Assessing the Impact of Climate Extreme on Crop Production

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Background/Objectives. Food security is expected to be heavily impacted by climate change in the coming decades, likely spawning humanitarian crises across various regions as the planet continues to warm. Although model simulations of various crops have been achieved to understand future changes in food security, many of these have failed to account for impacts from extreme events like drought and heave waves, which is reported to contribute up to 43% of variations in crop production based on historical model simulations. Furthermore, our croplands are projected to have an increasing probability of climate extremes. To understand the potential impact of climate extremes on crop production, the objectives of our work are to estimate crop yield of four staple crops of maize, rice, soybean and wheat in the next 100 years using a global land surface model, the community land model (CLM). Specifically, we aim to quantify how climate extremes in combination with fertilizer application and irrigation will impact the crop yield.

Approach/Activities. To accomplish our objectives, we run simulations using the Community Land Model version 5 with the crop model turned on (CLM5-crop). The model is forced by both historical and future climate data generated from the Coupled Model Intercomparison Project, version 6 (CMIP6) with and without droughts to determine how future climate is expected to impact crops. We focus our evaluation of results over major drought events (e.g., 10-year, 25-year and 100-year drought events) to understand their impacts on crop production during these critical periods. The model is tested over various quantities of fertilizer and irrigation application to determine how shifts in yield might differ for other aspects important to crop production. Model performance is assessed by comparing our results to a variety of data products generated by crop inventory and remote sensing data.

Results/Lessons Learned. Results are presented to highlight differences in yield during drought and non-drought periods as well as with varying levels of fertilizer and irrigation applications. Our results should shed light on where the most severe impacts of future droughts on food security will occur and the level to which management techniques such as fertilizer and irrigation application can be used to mitigate these impacts so we can better plan for these changes.